Report on the 111(d) Proposed Regulations

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THE VIRGINIA CENTER FOR COAL AND ENERGY RESEARCH
AT VIRGINIA TECH

VCCER | HISTORY & MISSION

- The Virginia General Assembly established the VCCER in 1977 as an "interdisciplinary study, research, information and resource facility for the Commonwealth."
- Three Broad Missions:
  - Conduct research on interdisciplinary coal and energy issues
  - Coordinate coal and energy research at Virginia Tech and statewide
  - Disseminate coal and energy research information to users in the Commonwealth
- The VCCER, since 1990, has prepared a number of reports on energy and environment, energy efficiency, energy economics and energy supply

VCCER AND THE VIRGINIA ENERGY PLAN (VEP)

- The VCCER is identified in § 67-201 of the Code of Virginia as one of the agencies to consult with the Department of Mines, Minerals and Energy (DMME) in the development of the VEP
  - VCCER's mandate was amended to explicitly include this responsibility to work on the VEP
- The 2014 amendments to §§ 67-201 and 67-202 of the Code of Virginia added new requirements to analyze regulations proposed or promulgated by the U.S. Environmental Protection Agency under Section 111(d) of the Clean Air Act
- VCCER's main responsibility was to prepare the report on the EPA's Clean Power Plan 111(d) proposed regulations (included as Appendix A1 of the VEP)

OVERVIEW OF REQUIRED ANALYSIS IN 111(D) REPORT

- The VEP 2014 amendment states (Item 8):
  - *8. With regard to any regulations proposed or promulgated by the U.S. Environmental Protection Agency to reduce carbon dioxide emissions from fossil fuel-fired electric generating units under § 111(d) of the Clean Air Act, 42 U.S.C. § 7411(d), an analysis of (i) the costs to and benefits for energy producers and electric utility customers; (ii) the effect on energy markets and reliability; and (iii) the commercial availability of technology required to comply with such regulations*

EPA BUILDING BLOCKS AND TARGETS FOR VIRGINIA

- EPA's proposed regulation includes four primary "building blocks" that states can adopt for compliance:
  1. Improve the unit heat rates at coal-fired plants by 6 percent
  2. Operate all existing and new Natural Gas Combined Cycle (NGCC) at a 70 percent capacity factor and "preserve" 6 percent of current nuclear capacity
  3. Implement mandatory state renewable energy programs reaching up to 13 percent of in-state generation by 2030
  4. Implement mandatory state energy efficiency programs equivalent to 10.7 percent of total generation by 2030

EPA PROPOSED LIMITS FOR VIRGINIA

- States are free to "mix and match" these building blocks to achieve compliance
- EPA's CO_2 emission targets for Virginia in the proposed rule are:
  - 991 lbs/MWh by 2020 and 810 lbs/MWh for 2030
    - An average of 884 lbs/MWh can also be used for the years 2020-2029
  - An "alternative" target of 962 lbs/MWh for 2025
- Conversion from rate based compliance (lbs of CO_2/MWh) to a mass based (tons of CO_2) approach is an option to encourage flexible trading programs (guidance on tons estimation was provided by EPA in November 2014)
- In all cases, 94% of the 2012 nuclear generation of the Commonwealth is not included in the MWh used to determine these limits

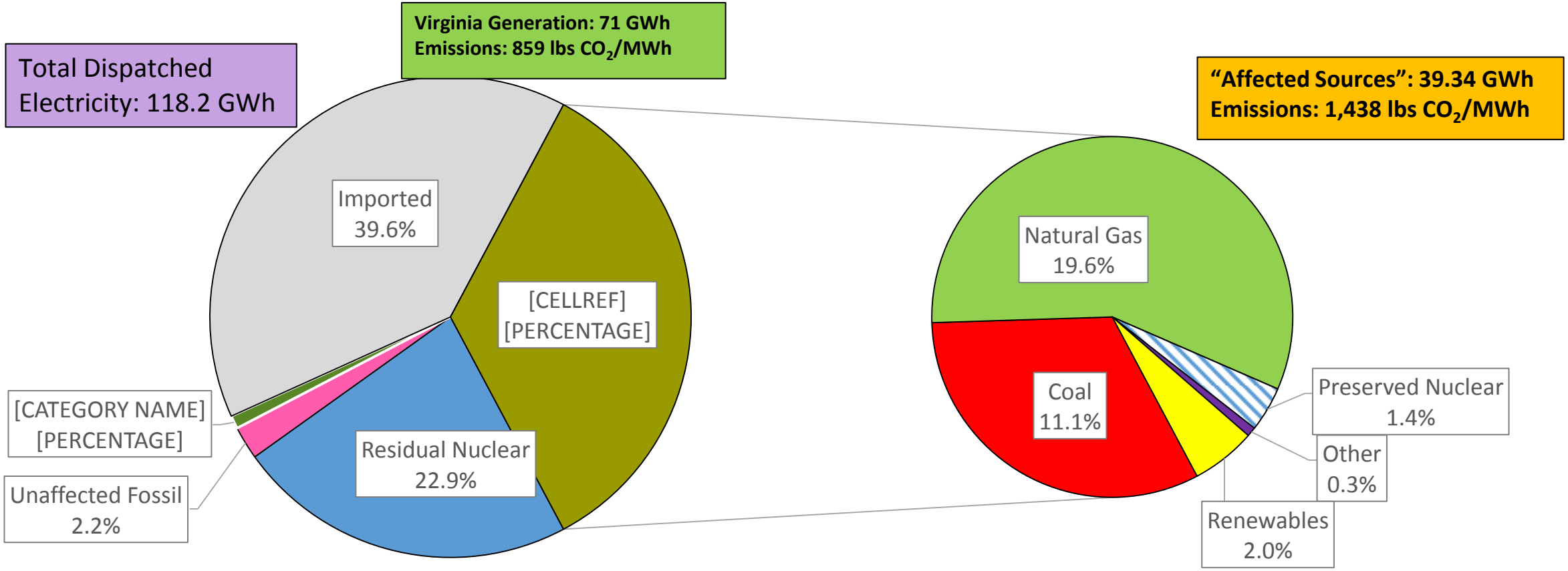
VCCER STUDY PRINCIPLES

- Address the EPA proposed CO_2 rule by:
  - Maintaining fuel and technology diversity, reliability of electrical system and resource integration
  - Minimizing negative impacts on cost and employment
- Develop a study that is a transparent effort supported by detailed documentation

BACKGROUND AND APPROACH OF THE VCCER STUDY

- Establish the base (2012) Virginia generation mix
- Review the requirements of EPA proposed rule
- Evaluate various scenarios to achieve compliance, the need for less-stringent standards or compliance schedules
  - Scenarios were developed by the agencies with VEP responsibilities
- Analysis of impacts of compliance options

2012 BASELINE VIRGINIA ELECTRICAL GENERATION



Source: EIA 2012

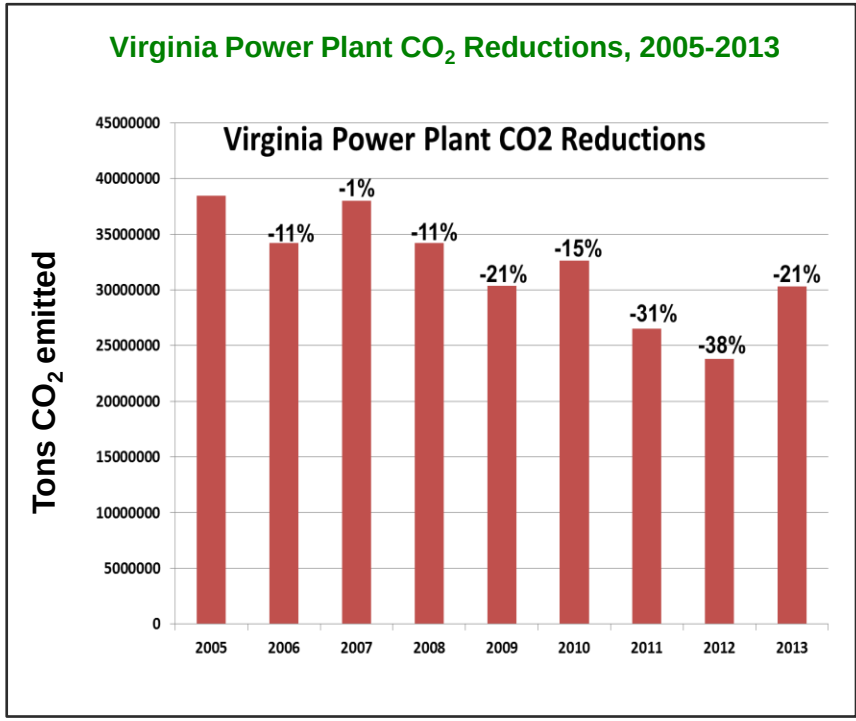
*Excludes net-negative pumped storage generation

REVIEW OF BASIC ASSUMPTIONS IN VCCER STUDY

- Fossil units considered in the analysis were in operation, or under construction, prior to January 8, 2014 (EPA rule)
- Only fossil plants above 25 MW capacity or >219 MWh output/year (in 2012) may be considered (EPA rule)
- VCCER accounted for announced retirements, conversions and construction of all fossil energy generation units
- Fossil energy generation was assumed to grow at 1.51% per year through 2030, based on utility industry estimates
- Total dispatched electricity was achieved by the "compliance" generation and all other sources (i.e., imports, residual nuclear and non-affected units)

VCCER STUDY ASSUMPTIONS: LIMITATIONS OF EPA'S BUILDING BLOCKS

- Coal-fired power plants in Virginia have implemented heat rate and other efficiency improvements for many years.
- Combined with low capacity-factor operation, for meeting emissions targets, only 3% improvement is practically achievable.
- Assumptions of 70% capacity factors for NGCC (existing and new) was accepted in calculations, but may be optimistic
- Increases in renewable energy generation are limited by the capacity for growth in Virginia
  - e.g., off-shore wind power will not be operational by 2020 and, if realized according to the proposed plan, could operate at low capacity by 2030
- Assumptions about energy efficiency growth rate maybe limited by practical annual changes



INPUT PARAMETERS

- Where outside data sources were used, VCCER relied on US Government official and widely accepted data:
  - Example: EIA/DOE on Cost Data (EIA, April 2014)

National Generation Cost ($/MWh 2019 Cost in 2012 Dollars)					
Fuel	**Levelized Capital Cost**	**Fixed O&M**	**Variable O&M (including fuel)**	**Transmission Investment**	**Total**
Nuclear	$71.40	$11.80	$11.80	$1.10	$96.10
Coal	$60.00	$4.20	$30.30	$1.20	$95.60
Natural Gas	$14.30	$1.70	$49.10	$1.20	$66.30
Biomass	$47.40	$14.50	$39.50	$1.20	$102.60
Renewable	$124.20	$18.70	$1.30	$4.20	$148.40

Renewables Total Cost Varies (in 2012 $/MWh):
- On-Shore Wind: $80.3
- Solar: $130.00
- Off-Shore Wind: $204.10

VCCER METHODOLOGY

- Consistent with EPA requirements and guidelines
- Based on individual generating units, not at power plant level
- Iterative, expert-driven solutions via spreadsheet
- Documented and reported data and results
- VCCER approach on existing generating units
  - Coal-fired
    - Consolidate generation to large, high efficiency, new units with best environmental controls
    - Terminate older, smaller units
  - Natural Gas Combined Cycle
    - Increase generation at large, high efficiency, low CO_2-emitting units
    - Operate smaller, higher CO_2-emitting units sparingly

VCCER SCENARIOS

- A number of scenarios were considered to evaluate possible compliance approaches for comparison
- The scenarios range from maintaining a status quo (not meeting EPA compliance), to eliminating coal generation, to cases based on EPA building blocks and utilizing existing generation fleet
- Certain scenarios include:
  - "Incremental" case (dispatch of the next lowest cost power to meet demand)
  - "Green" case (using maximum practical levels of renewable energy and energy efficiency)

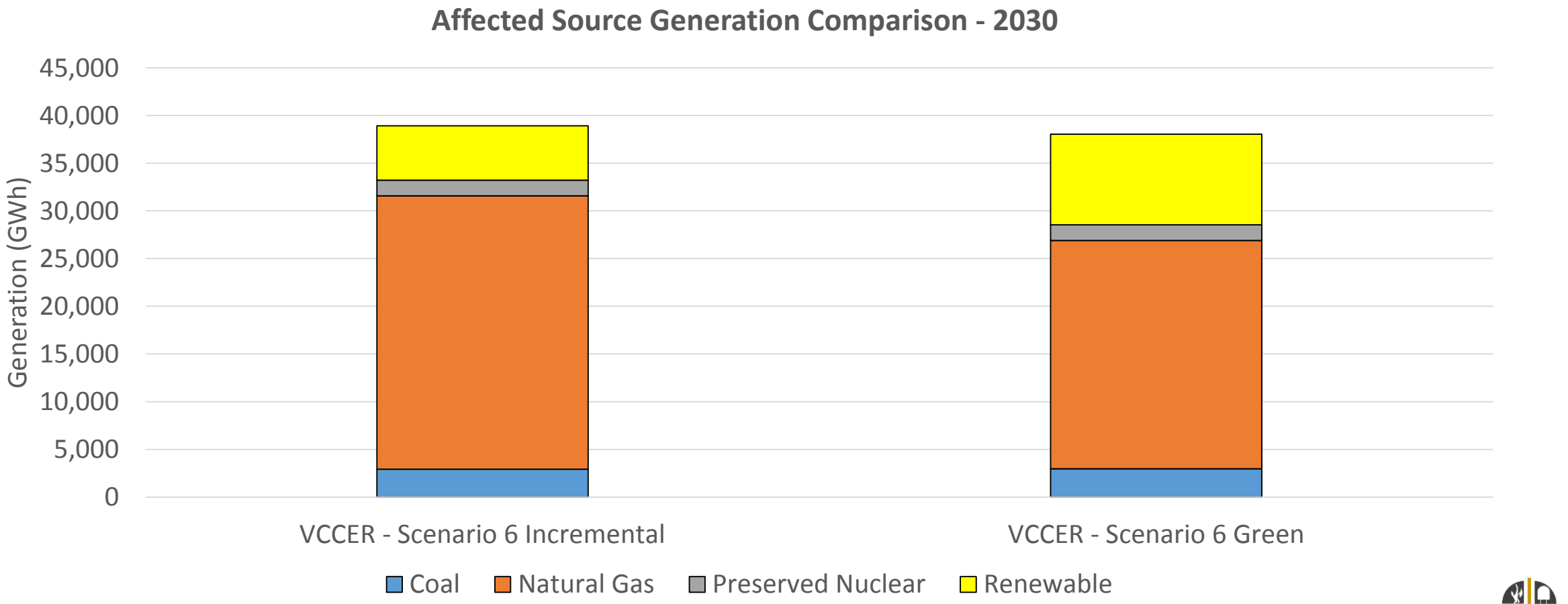
SCENARIO 2: THE STATUS QUO, NON-COMPLIANCE

- Updated the base line scenario of 2012 by incorporating retirements, conversions and announced additions
- Preserved nuclear generation is included
- Reflects essentially the status quo or "do nothing case"
- The CO_2 emission rate for Scenario 2 is 1,142 lbs/MWh
- Economic impacts and changes in predictions under the various scenarios are compared with respect to Scenario 2

COMPLIANCE SCENARIO 6: MEETING EPA'S GOALS FOR VIRGINIA

- Scenario 6 in VCCER's report was designed as one means of achieving compliance with EPA goals for 2020 and 2030
- The assumptions are based on using a mix of the EPA building blocks to achieve compliance
- The "incremental" case assumed power would be dispatched based on generating cost alone, thus favoring natural gas and existing units
- The "green" case gave preference to renewable energy and energy efficiency in addition to using cost
  - For 2030, the renewable share for the green case was increased from 5.7 GWh to 9.5 GWh and the energy efficiency from 0.4 GWh to 1.35 GWh

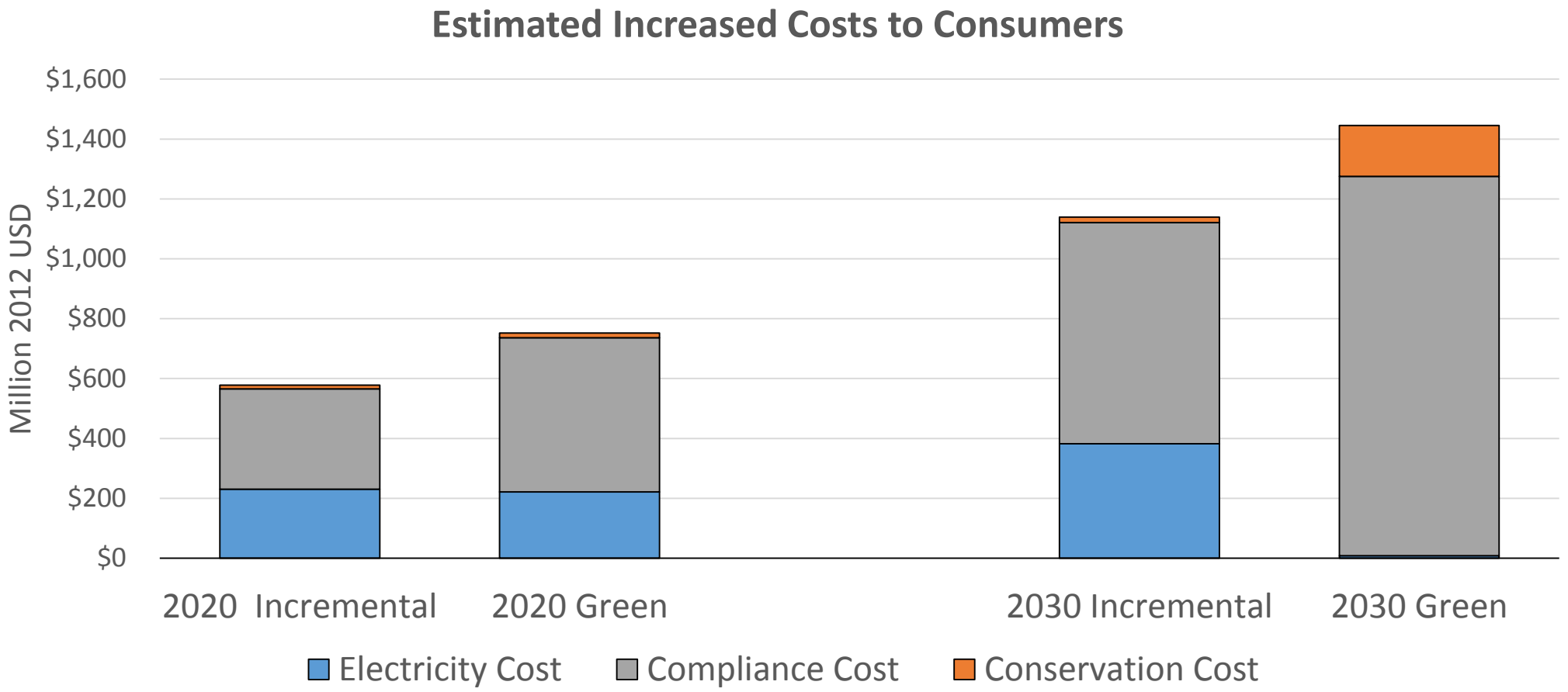
POTENTIAL 2030 VIRGINIA GENERATION MIX, VCCER AND SELC ANALYSIS



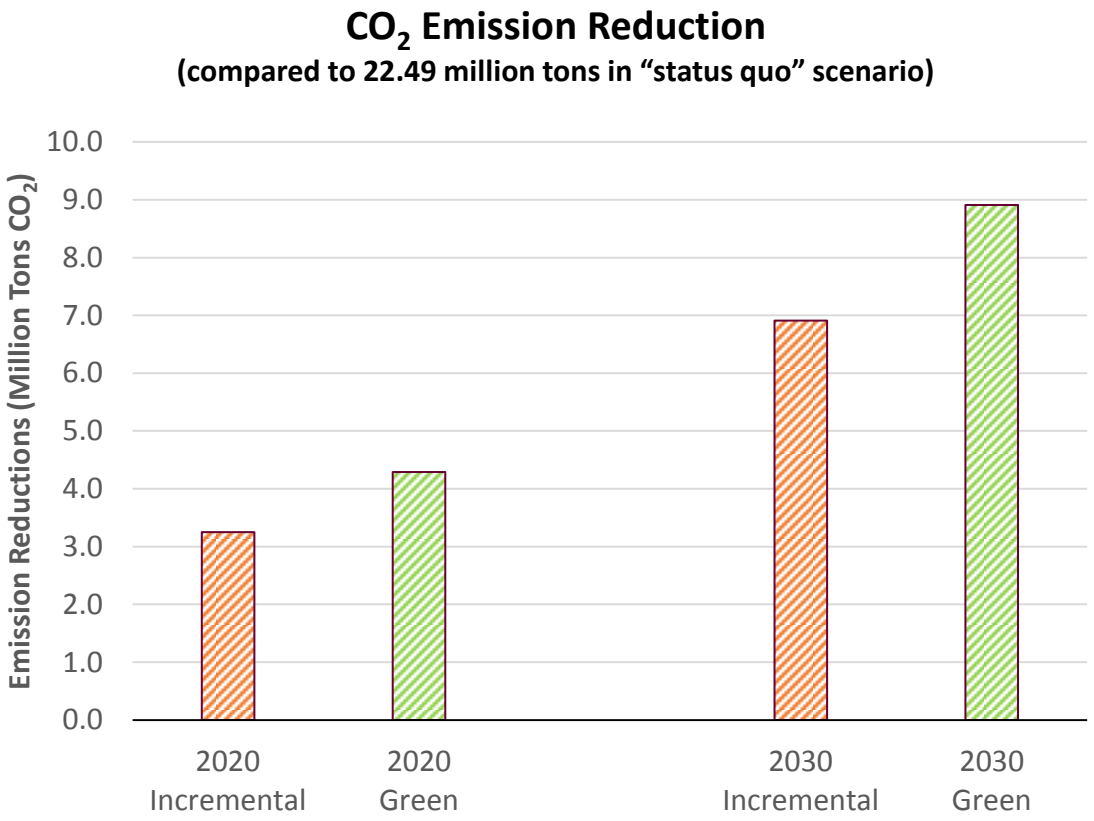
COST AND BENEFIT DEFINITIONS

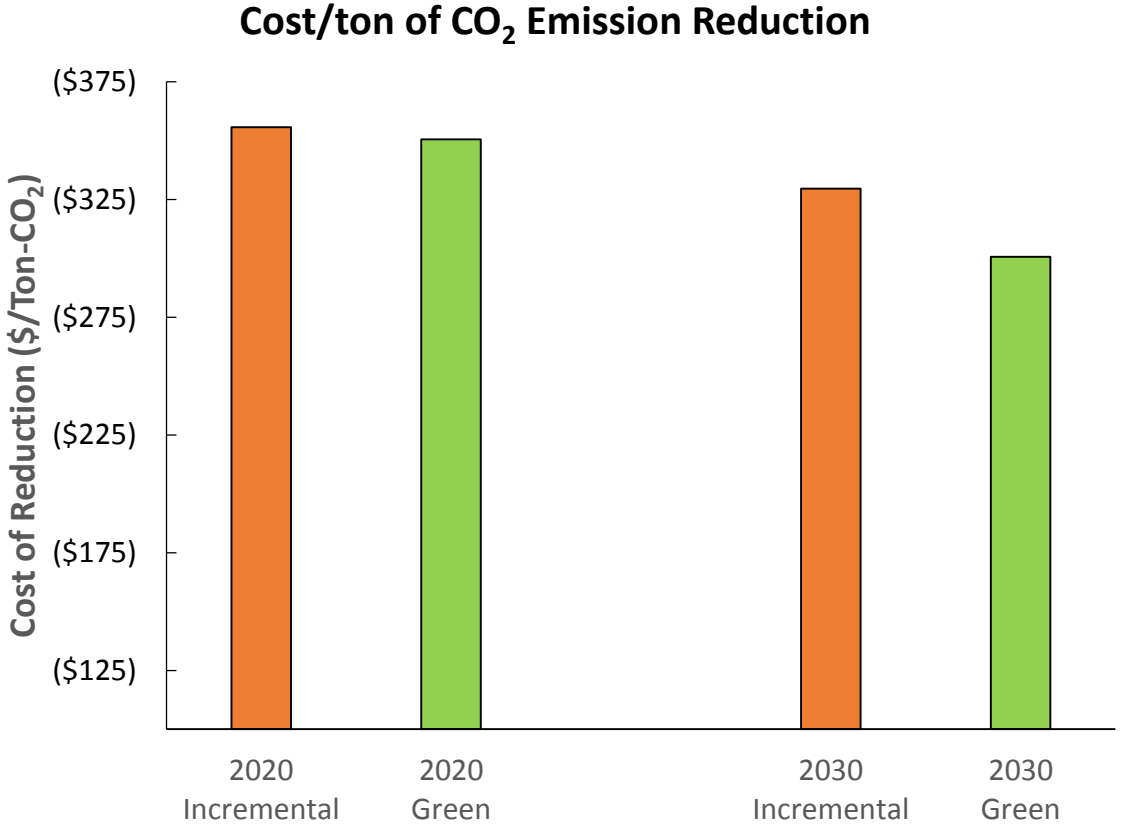
- **Compliance cost** – Includes capital costs for fuel-switching and costs for plant decommissioning, operations and maintenance, supply-side conservation, heat rate improvements and other efficiency measures, as well as changes in fuel costs
- **Electricity cost** – Uses EIA published 2012 electricity rates for Virginia for residential and business consumers, escalated by a consumer base growth of 0.8 percent annually and a nominal price increase of 3.2 percent annually
- **Conservation cost** – Based on EPA data and reflects the cost of demand-side conservation implemented by residential and business consumers
- **Social cost of carbon** – Based on EPA's analysis of global impacts of carbon emissions
  - Benefits are global and method is controversial
- **Health benefit** – Based on the EPA's analysis of health benefits tied to reduction of other (non CO_2) "pollutants" that will occur as a result of changes to the generation mix
  - Health co-benefits may be double counted from other EPA rules

ANNUALIZED TOTAL COSTS TO CONSUMERS UNDER SCENARIO 6

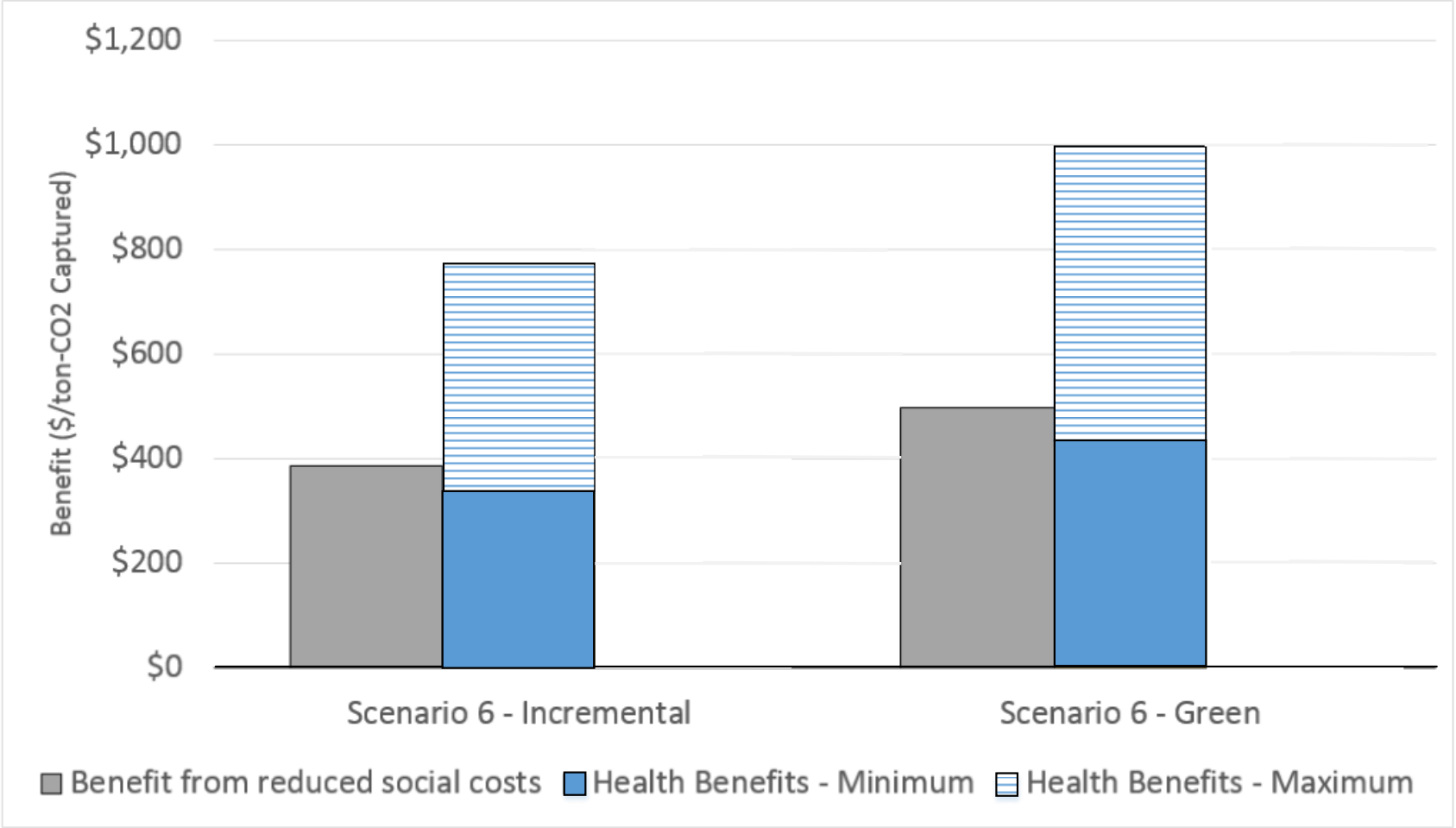


COSTS TO CONSUMERS PER TON OF CO_2 REDUCED

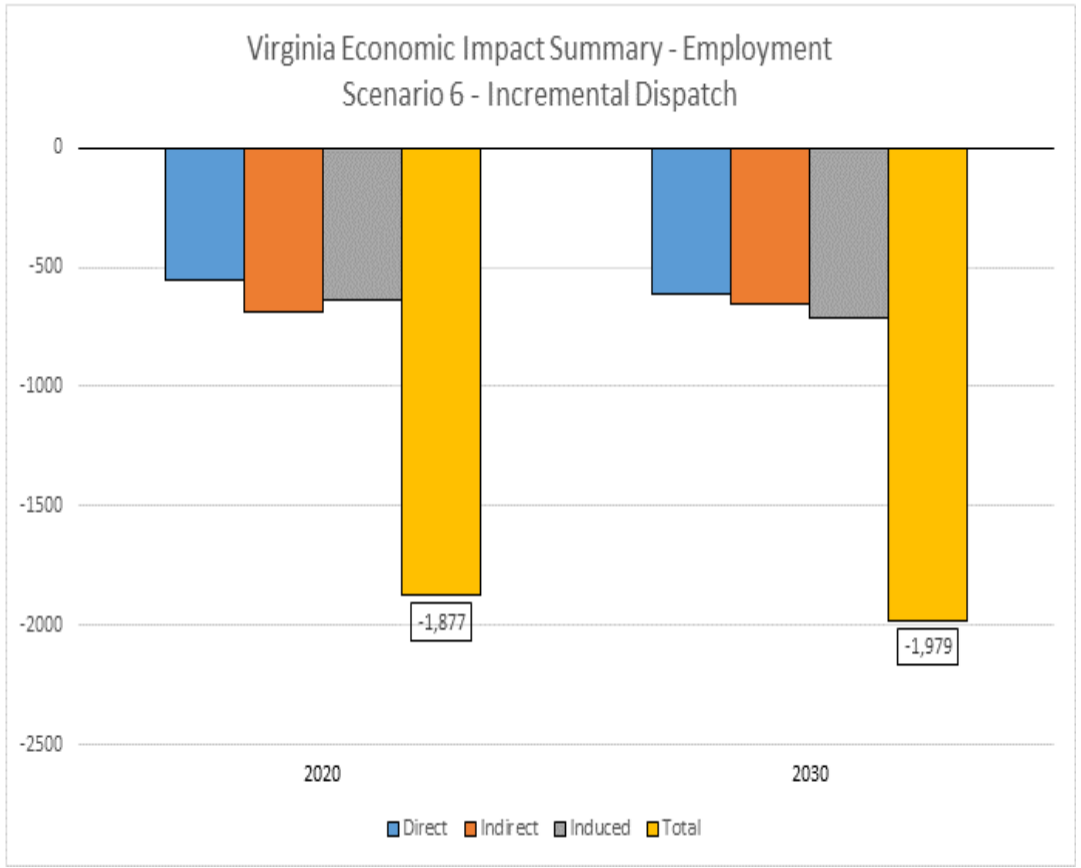


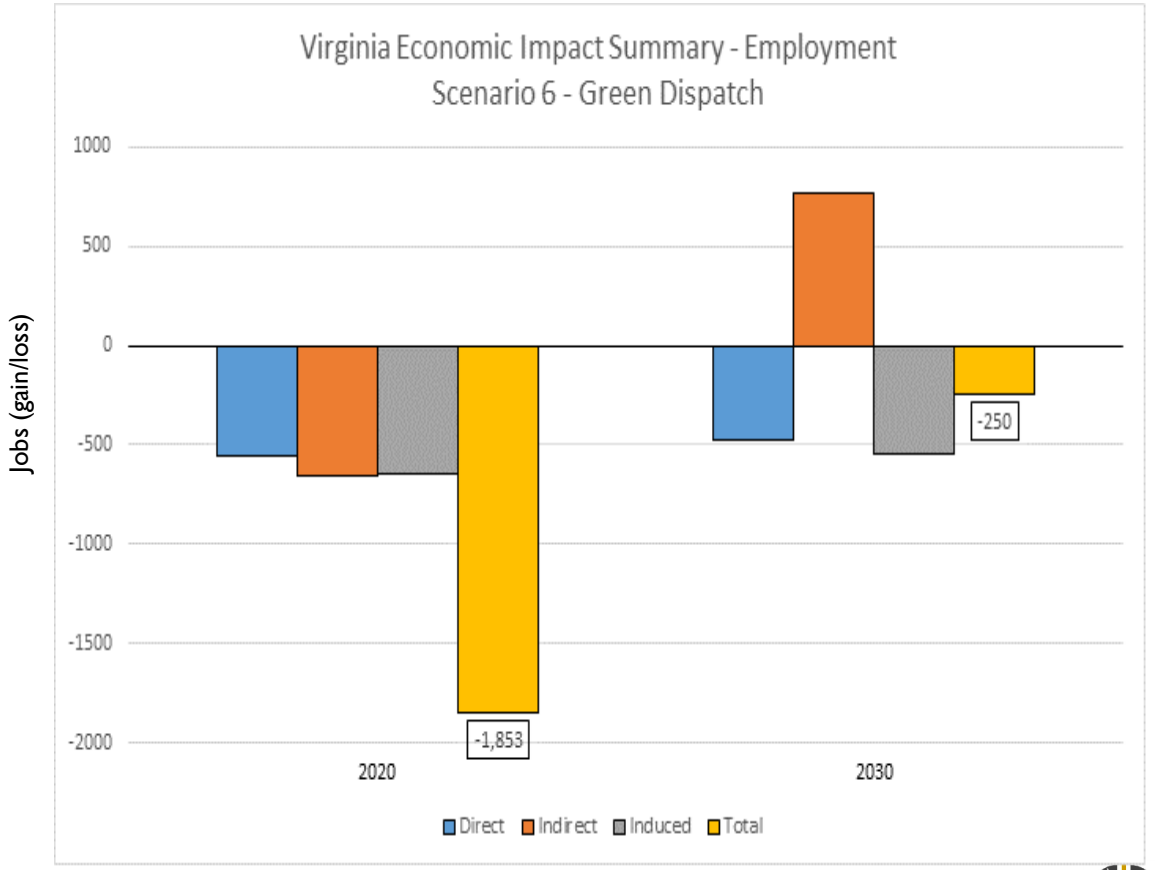


BENEFITS PER TON OF CO_2 REDUCED - 2030



EMPLOYMENT IMPACTS UNDER SCENARIO 6 - 2030





COMPLIANCE AND IMPACTS OF CPP IN VIRGINIA

- Compliance:
  - A different generation mix
  - Increases in natural gas, decreases in coal generation, greater contributions from renewables and energy efficiency
  - Reliability concerns based on fuel diversity and need of supporting gas pipelines and related infrastructure
- Costs:
  - Electrical generating sector will incur higher costs to meet Virginia's electricity demand
  - Higher costs for consumers and businesses, including the expected pass-through costs from generators
- Employment:
  - Negative employment impacts in electrical generating sector as well as in coal mining and other industries
  - Indirect and induced employment impacts also could be large
- Benefits (based on EPA definitions and methodology):
  - Reduction of the "social cost of carbon" and health "co-benefits" from reduced CO_2 emissions

COMPARISON OF VCCER REPORT TO OTHER REPORTS AND ANALYSES OF THE 111(D) RULEMAKING

- Several other studies and analyses have addressed the EPA proposal, which converge or diverge in their findings based on differences in assumptions, input parameters and methodologies utilized
- For example, the VCCER report:
  - Follows the EPA Appendix 1 and 7 Approach
  - Does not include non-compliance generation
  - Uses reasonable, experience-based, assumptions on identifying affected units, i.e., heat rate
  - Incorporates input from actual unit data, not "generic proxy unit data"
  - Employs an iterative, expert-driven solution via spreadsheet with well documented and reported data and results

OTHER FEATURES OF THE VCCER REPORT

- Assumes a mixture of solar, on-shore and off-shore wind for renewable sources
- Uses existing/announced biomass facilities and 20% of fuel (maximum biomass) at Virginia City
  - Concerns about the "carbon debt" of biomass power generation, CPP "requires clarification on how biogenic (biomass) carbon emissions will be handled." - VEP, p. 93
- Assumes achievable rather than aspirational goals on energy efficiency
- Assessments of costs is based on total compliance and generation costs
- Employment impacts are calculated using a well proven sector analysis methodology, i.e., JobsEQ and IMPLAN models
- Benefits of the proposed rule are based on the EPA supporting documents

SUMMARY

- Studies share a common theme:
  - Virginia can achieve compliance but with a different generation mix
  - Compliance will require significant increases in natural gas generation, decreases in coal generation and greater contributions from renewables and energy efficiency
  - Reliability concerns based on natural gas dominance in the generation mix, heightened by the need to complete additional gas pipelines and related infrastructure in time
  - There are costs and benefits in reducing CO_2 emissions to the proposed EPA limits
- Studies show variances because of different input parameters, assumptions and methodology:
  - Compliance generation mix
  - Achievable levels of renewables and energy efficiency
  - Reliance on natural gas
  - Estimates of cost and employment impacts